N92-22020

ADVANCED TRACKING AND DATA RELAY SATELLITE SYSTEM

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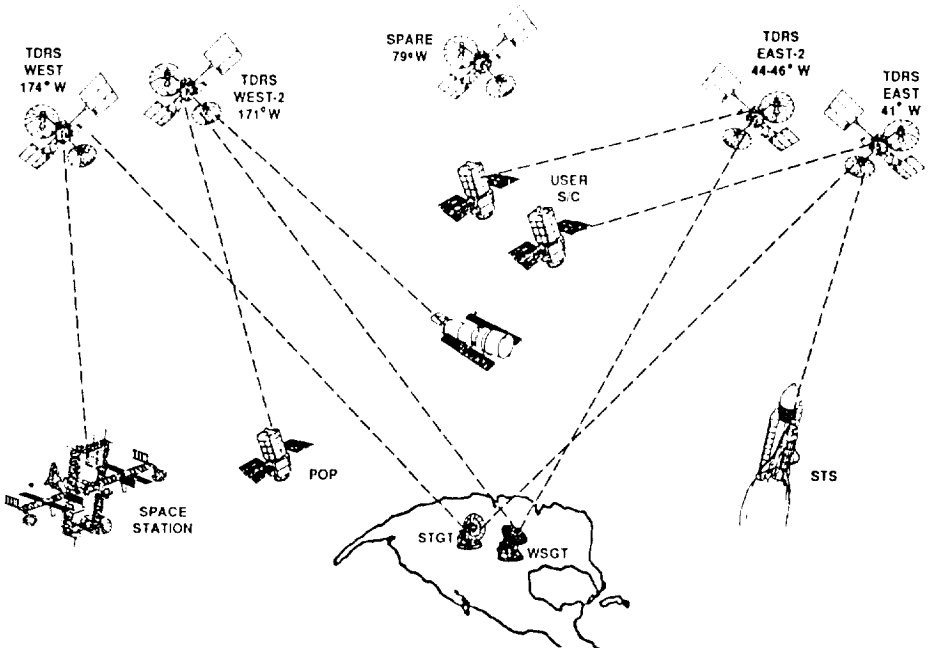
ADVANCED TDRSS

PURPOSE:

- Provide NASA needs for satellite tracking and communications through the year 2012
- Maintain and augment the current TDRS System when available satellite resources are expended in the latter part of the next decade
- Provide the necessary ground upgrade to support the augmented services
- Introduce new technology to reduce system life-cycle cost.

ATDRSS Configuration



TDRS LAUNCH SCHEDULE

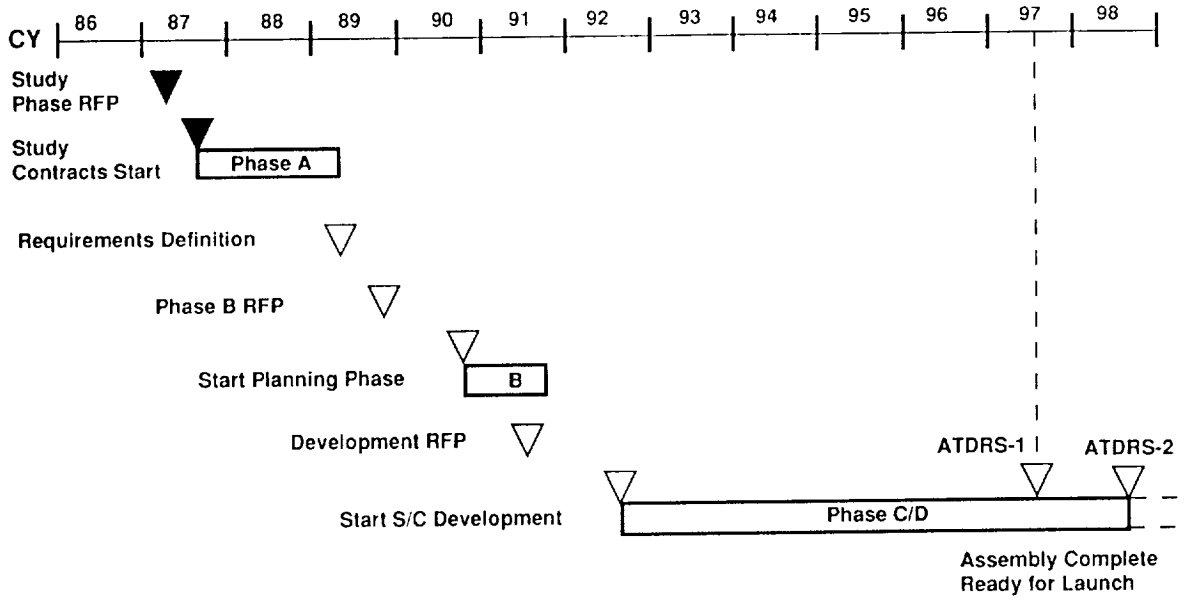
TDRS 1 - Launched 4/83; Degraded Capability
TDRS 2 - Lost in Challenger accident 1/86
TDRS 3 - Launched 9/88
TDRS 4 - Launched 3/89; replaced F-1

TDRS 5 - In orbit spare in 1990
TDRS 6 - Ground spare or fourth satellite in constellation
TDRS 7 - Replacement spacecraft; available 1992
TDRS 8 - Optional spacecraft; not available before 1994
ATDRS - Advanced TDRS; not available before July 1997

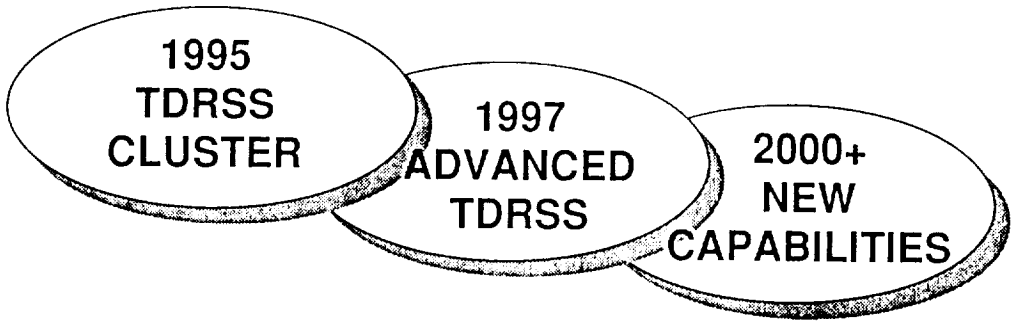
ADVANCED TDRSS STATUS

- Completed 18-month Conceptual Design Studies (Phase A) in March; Ford, GE, Hughes, Lockheed, TRW
- Phase B RFP to be released in August 1989 for a competitive award to multiple contractors
- Delivery of the first ATDRS is planned for July, 1997

ATDRSS PROGRAM SCHEDULE



TDRSS EVOLUTION



- Capability Increase to 8 SA's with 4th Spacecraft

- 8 SA's
- Enhanced S-Band
- Ka-User SGL
- Satellite Expansion Capability
- Navigation Beacon (study)

- 650 MBPS Return
- Geo. Coverage
- Increased Spacecraft autonomy
- Demand Access (study)

- Cross Links
- Direct Data Distribution
- Laser Links
- Interoperability with Foreign DSR's

POTENTIAL SERVICES UNDER EVALUATION

	Status
• Cost vs. benefit of closing the zone of exclusion	Defer
• Increased single access capacity (>300 Mb/sec)	✔
• Direct downlink to some locations or users	Defer
• Demand Access on MA channels	Study
• Interoperability with other data relay satellite systems	Defer
• Increased satellite reliability and redundancy	✔
• GEO user coverage	✔
• Command/Navigation Broadcast (Beacon)	Study
• Pre-Operational Demonstration (Satellite Expansion)	✔

TDRSS / ATDRSS
BASELINE SERVICE COMPARISON

Single Access		Max. Rate (MBPS)	No. of Channels: 1996 TDRSS Cluster	No. of Channels: 2003 Advanced TDRSS
S-Band	FWD	0.3	8	4* + Spare
	RTN	6		
Ku-Band	FWD	25	8	4* + Spare
	RTN	300		
Ka-Band	FWD	50		4* + Spare
	RTN	650		
	Total No. of Independent Pointable Antennas		8	8 + 2 Spare

		TDRSS	ATDRSS
Multiple Access	FWD	4 @ 10 KBPS	8 @ 10 KBPS (+3 dBW)
	RTN	20 @ 50 KBPS	12 @ 3 MBPS**

	TDRSS	ATDRSS
Tracking Accuracy	150 M, 3 σ	Study Improvement to 50M, 3 σ

* Minimum- possibly larger ** MA Gain equal to TDRS Single Access - S-Band

QPSK

- Expansion to Ka-Band obviates need for highly bandwidth-efficient modulation techniques
- Minimizes User and Spacecraft impact

ATDRSS MODULATIONS

Telecommand: SQPN and data
- PN Range and Command Channel PN Spread for ≤ 300 KBPS
- New 50 MBPS Ka-Band is Balanced SQPSK

Telemetry:

- DG1, mode 1+2 — SQPN and data
  - PN Spead at Lower Rates
- DG1, mode 3 — PSK in quadrature
  - Only I-Channel is PN Spread
- DG2 — BPSK, QPSK, SQPSK
  - Unbalanced and Balanced Mode
  - SQPSK Used for Equal I & Q Data Rates

ATDRSS SIGNAL PARAMETERS

- Bent-Pipe as TDRS
- 1×10^{-5} BER
- Convolutional Encoding/Viterbi Decoding at 1/2 & 1/3 rates for some modes as in TDRS
  - User can provide own End-to-End Encoding

CONCLUSIONS

- No ATDRS Spacecraft Requirement for New Modulation Techniques
- Data Rate of 650 MBps is Required
  - Opportunities Exist for Applications of Advanced Modulation Techniques for Ground Data Distribution
- Space Station Freedom Requirement for 650 MBps Data Some Time After the Year 2000